TOPIC 18 – HL ACIDS/BASES
18.3 – SALT HYDROLYSIS

IB Chemistry

T18D06

18.3 Salt hydrolysis - 1 hour

- 18.3.1 Deduce whether salts form acidic, alkaline or neutral aqueous solutions. (3)
- A **Salt** is defined as a compound formed when the hydrogen of an acid is completely (normal salt) or partially (acidic salt) replaced by a metal.

Acid	Salt	Example
HCl	Chlorides	NaCl
HNO_3	Nitrates	$NaNO_3$
CH_3COOH	Ethanoates	CH_3COONa
H_2SO_4	Sulfates (normal salts) Hydrogensulfates (acid salts)	Na_2SO_4 $NaHSO_4$
H_2CO_3	Carbonates (normal salts) Hydrogencarbonates (acid salts)	Na_2CO_3 $NaHCO_3$
HCN	Cyanides (normal)	NaCN

18.3 – Acid Salts

- If soluble in water, acid salts, dissolve to form acidic solutions
  - $NaHSO_4(s) + (aq) \rightarrow Na^+(aq) + H^+(aq) + SO_4^{2-}(aq)$
  - The resulting solution is acidic (hence the H^+) and exhibits typical acidic properties such as turning litmus paper to blue

18.3 – Normal Salts

- If soluble in water, normal salts often dissolve to form neutral solutions
  - $NaCl(s) + (aq) \rightarrow Na^{+}(aq) + Cl^{-}(aq)$
- This occurs when the salt has been formed by the neutralization of a **strong acid** with a **strong base**
  - $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
- But, some normal salts dissolve in solution to form acidic or basic solutions. This is because one of the ions is the conjugate of a strong acid or base. This process is **salt hydrolysis**

18.3 – Salt Hydrolysis

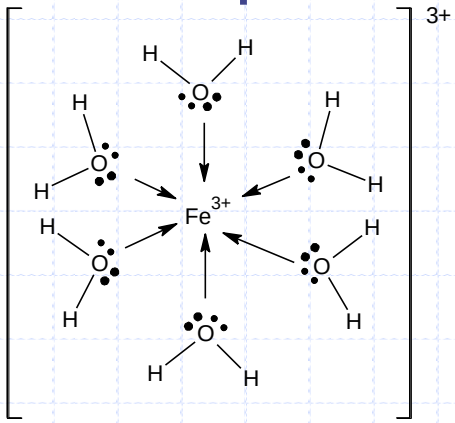
- An example of salt hydrolysis would be from a **weak acid** and **strong base**
- $Na_2CO_3(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) + NaOH(aq)$
  - $CO_3^{2-}(aq) + H_2O(l) \rightleftharpoons H_2CO_3(aq) + OH^-(aq)$
    - Na^+ is a spectator: W. Acid S. Base
  - Resulting solution contains an excess of $OH^-(aq)$ ions and is alkaline with a pH>7
- From a **weak base** and **strong acid**:
- $NH_4Cl(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + HCl(aq) + H_2O(l)$
  - $NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H_3O^+(aq)$
    - Cl^- is a spectator: W. Base S. Acid
  - Resulting solution has excess $H^+(aq)$ and pH<7

18.3 – Neutral Salt Hydrolysis

- If both ions that react in an aqueous solution dissolve to form the conjugates of weak species (acid and base) the resulting solution will be neutral.
- From **weak acid** and **weak base**:
- $CH_3COONH_4(aq) + 2H_2O(l) \rightleftharpoons NH_3(aq) + CH_3COOH(aq) + H_3O^+(aq) + OH^-(aq)$
  - ½ For ethanoate ion: $CH_3COO^-(aq) + H_2O(l) \rightleftharpoons OH^-(aq) + CH_3COOH(aq)$
  - ½ For ammonium ion: $NH_4^+(aq) + H_2O(l) \rightleftharpoons NH_3(aq) + H^+(aq)$

18.3 – Metal Cation Salt Hydrolysis

- Differing example can result from the dissolving of small and highly charged metal cations in aqueous solution.
  - Copper (II) sulfate, Cu_2SO_4
  - Aluminum sulfate, $Al_2(SO_4)_3$
  - Iron (III) chloride, $FeCl_3$



  - $Fe[(H_2O)_6]^{3+}(aq) + H_2O(l) \rightleftharpoons Fe[(H_2O)_5OH]^{2+}(aq) + H_3O^+(aq)$
    - Occurs rapidly with many **trivalent** cations (Fe^{3+}, Al^{3+})
    - Occasionally with 2+ ions (Cu^{2+})
    - Not at all with unipositive ions (Ag^+)

18.3 – Salt Hydrolysis

- In summation:
  - Acid Salts form acidic solutions
  - Normal salt of SB/SA = neutral
  - Normal salt of wB/SA = acidic
  - Normal salt of SB/wA = basic
  - Normal salt of wB/wA = neutral
  - Trivalent Cation Salts can form acidic solutions